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RIO NIDO LANDSLIDE
SONOMA COUNTY, CALIFORNIA

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A destructive landslide occurred in the Rio Nido residential area of Sonoma County in the evening of February 6, 1998. The Rio Nido area received prolonged and intense rainfall prior to the landslide. On February 7, 1998, DMG was requested by the Governors Office of Emergency Services to evaluate the impacts of the landslide and assess the potential for additional failures that may affect the residents of that community. DMG Headquarters in Sacramento responded that day by dispatching Wayne D. Haydon to the Sonoma County Emergency Operations Center in Santa Rosa to coordinate with county and state officials dealing with the landslide. This report will present a brief review of the California Department of Conservation, Division of Mines and Geology's (DMG) investigations, conclusions and recommendations regarding the Rio Nido landslide.

INVESTIGATIONS

On February 7, 1998, Wayne Haydon and Dr. Tom Anderson of Sonoma State University conducted a helicopter overflight of the landslide and surrounding area to observe the extent of the failure and assess the overall stability of the slopes adjacent to the landslide. On February 8, 1998, Wayne Haydon, Dr. Tom Anderson and Eric Mays, Sonoma County Supervisory Building Inspector, conducted a field inspection of the landslide and the adjacent slopes. Wayne Haydon also reviewed DMG Special Report (SR) 120, *Geology for Planning in Sonoma County,* to obtain information on the geology and aerial extent of existing landslides in the Rio Nido area.

GEOLOGIC CONDITIONS

The Rio Nido area is underlain by pervasively fractured and shattered, interbedded sandstone and shale of the Franciscan Complex. This rock is intensely weathered and friable. Drainages underlain by the Franciscan Complex commonly accumulate varying thickness of loose and weak soil like colluvium. The drainage in which the landslide occurred was mapped in SR 120 as containing an existing landslide, as were many of the other drainages in the Rio Nido area. The Franciscan Complex, in general,

consists of relatively weak, broken rock. Areas underlain by these rocks and the accumulated colluvium are considered to be relatively unstable and contain abundant landslide.

OBSERVATIONS

The Rio Nido landslide is in an east-facing drainage directly upslope and west of Upper Canyon Three of Rio Nido [Please see the attached maps]. The top of the landslide is located just below the east-facing ridgeline (at an approximate elevation of 720 feet). The landslide flowed down the hillslope drainage to the canyon floor, which has an elevation of approximately 120 feet. The total drop in elevation of the landslide mass is about 600 feet. Fire Department Captain Dave Miinch of the Russian River Fire Department, who was in the canyon when the landslide occurred, stated that the first small failure occurred at 10:35 PM on February 6 and that a larger failure occurred at 1:30 am on February 7.

The landslide consists of two parts – the main portion is a 500-feet-wide rotational block that has a debris flow at its toe, while a 100-feet-wide debris flow is located along the north margin of the rotational block. Total width of the landslide headscarp is about 600 feet. The headscarp is arcuate in shape and is about 30 feet high near its center. The headscarp diminishes in height toward the north and south, until it disappears at the margins of the landslide. The bedrock material exposed in the headscarp consisted of intensely fractured and weathered sandstone typical of the Franciscan Complex.

Directly below the headscarp the rotational block has dropped (slumped) a maximum of about 30 feet down the headscarp. This block has rotated down and to the east (coming out of the slope) and tilted backwards, so the surface of the block now slopes slightly back into the slope. The rotational block varies between 100 and 200 feet in width. The field team was not able to ascertain the precise downslope extent of the rotational failure, but the thickness of the rotational block was estimated to be about 50 to 100 feet. Therefore the base of the rotational block is estimated to be at about an elevation of 600 to 650 feet. Additional field work would be required to identify the downslope extent of the rotational movement. The rotational block has broken up into a number of smaller blocks, each of which has dropped downslope about 1 foot and has a scarp roughly parallel to the headscarp. This rotational block also has a dense canopy of trees, many of which are now tilting in various directions and leaning against each other as a result of the breaking up of the larger block. Surface water is ponding on the rotational block directly below the headscarp.

At the toe of the rotational block the slope materials failed, forming a debris flow that moved downslope to the canyon floor, where it was deposited as a debris fan. This debris flow destroyed 3 or 4 homes on the west side of the canyon floor and deposited debris across to the east side of the canyon. The debris fan diverted the unnamed creek that flows down Upper Canyon Three to the east. The creek is now flowing in several new channels across the debris fan. Surface water was observed flowing down the margins of this debris flow.

The debris flow along the northern margin of the landslide flowed directly east from the headscarp down a shallow drainage, but does not appear to have reached the canyon floor.

CONCLUSIONS

Based on the overflight and field inspection the following conclusions were reached:

1. The Rio Nido Landslide is a complex landslide consisting of a rotational slump with debris flows at the toe of the rotational slump and along the northern margin. It is estimated that the rotational block is about 50 to 100 feet thick. The estimated volume of the rotational block is about 140,000 to 250,000 cubic yards (yds) and the estimated volume of the fluidized material on the canyon floor is about 20,000 to 30,000 yds. The debris flow that mobilized at the toe of the rotational slump flowed down to the canyon floor, destroyed 3 or 4 homes, depositing a debris fan and diverted the creek. The debris flow along the northern margin of the landslide flowed eastward but did not reach the canyon floor. The cause of the landslide is most likely the prolonged and intense rainfall received in the Rio Nido area prior to the failure. This rainfall has saturated the rock and colluvial material, reducing the material's strength and increasing it's weight, until the material failed.

2. The primary future hazard from this landslide is the failure of the rest of the rotational block and the movement of this landslide material to the canyon floor where it can impact additional residences. While it is not possible to predict if and when the rotational block will fail, the rainfall forecasted for this week will most likely further destabilize the mass and increase the likelihood of a failure. The fact that the rotational block is already breaking up suggests that it may fail in pieces, reducing the amount of material delivered to the canyon floor at any one time.

3. A secondary future hazard is the damming of the creek and formation of a small lake behind the dam. Formation of the dam would be from the downslope failure of the rotational block. Potentially this dam would fail, releasing the stored water and causing downstream flooding. The liquid nature of the failed material will prevent the forming of a high dam, but will instead spread out forming a low wide dam. The fact that the rotational block is breaking up suggests that it may fail in pieces, reducing the amount of material delivered to the canyon floor at any one time and therefore reducing the volume of water stored behind the dam.

RECOMMENDATIONS

Sonoma County personnel requested recommendations on the evacuation areas. I made the following recommendations:

1. The mandatory evacuation area should include all of Upper Canyon Three. I believe this is the area mostly likely to be affected by additional failures.

2. I agreed with Sonoma County personnel that additional landslides may occur in other canyons in the Rio Nido area because rainfall and the geologic material are similar throughout the area. Therefore, I agreed with the County staff that an advisory evacuation seemed appropriate for all of Rio Nido and that people should be advised to be able to leave their homes with only a few minutes warning.

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Concur:

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Date Trinda L. Bedrossian, CEG 1064
Supervising Geologist

Attachments